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Original article

Assessment of the relationship between nutritional status, inflammatory marker CRP and serum immunoglobulin G, M, A in adults

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Summary. *Background.* Inflammation is the common denominator of atherosclerosis, cardiovascular diseases, obesity, metabolic syndrome and type 2 diabetes. There are studies confirming the involvement of the immune system in acute myocardial infarction, metabolic syndrome, obesity and diabetes. However, data evaluating the relationship between markers of nutritional status and the concentration of immunoglobulins are insufficient. *Aim.* The aim of this study was to investigate the relationship between selected markers of nutritional status, age, inflammatory markers CRP and immunoglobulin G, A and M in adults. *Material and Methods.* The study included 114 people aged 45+. Nutritional status was assessed on the basis of anthropometric measurements, lipid profile indicators and fasting glucose. The concentration of the inflammatory marker CRP was determined by the high-sensitivity method and the concentration of immunoglobulin G, A, M by the immunoturbidimetric method. Assessment of the gender differences was based on one-way analysis of variance and analysis of the relationship between nutritional markers, CRP and immunoglobulin based on linear regression analysis. *Results.* A major problem in the study population was the occurrence of metabolic disorders in the form of excess body weight, lipid profile and carbohydrate metabolism disorders. It was shown that IgA levels correlated positively with waist circumference and WHR. No significant correlations were found between the remaining nutritional status markers assessed, C-reactive protein and IgA, IgG and IgM concentrations. *Conclusions.* The findings confirm the hypothesis that the immune system is involved in the pathogenesis of obesity, in particular the abdominal type. More research is needed to explore mechanisms which increase serum IgA among obese patients. However, one limitation of this study is the relatively small experimental group. It is necessary to conduct tests on a large population, which could confirm these dependencies.

Keywords. C-reactive protein (CRP), immunoglobulins, metabolic disorders, lipid profile, fasting blood glucose.

Introduction

Numerous clinical and population studies indicate that moderate intensity chronic inflammation and the associated vascular endothelial dysfunction play a crucial role in the pathogenesis of cardiovascular diseases, at the root of which is atherosclerosis, which was named an inflammatory disease in 1990 (1-4). Elevated levels of C-reactive protein analysed by the high-sensitivity method (hsCRP) reflects inflammatory activity within atherosclerotic plaque and is used to assess the risk of cardiovascular events (1, 5). In recent years, research also highlights the role of inflammation as a factor in inducing insulin resistance. Hyperglycemia itself also leads to vascular endothelial dysfunction and increases inflammation (6). The increased concentration of IgA is a common phenomenon in people with diabetes (7). There is also evidence confirming the involvement of the immune system in cardiovascular diseases and metabolic syndrome. Sinkiewicz et al. (8) conducted studies on patients with acute myocardial infarction with IgE> 100kU / l and found a positive correlation between log serum IgE and low-density lipoprotein (LDL-C) (p <0.05), and lipoprotein (a) (P <0.02) and a negative with high-density lipoprotein (C-HDL) (p <0.02). Their research also showed a significant association with IgE concentration and increased levels of thrombogenesis markers and the correlation persisted after myocardial infarction. The authors speculated that the IgE may participate in the atherothrombotic process. Kotłowski et al. (9) studies among patients with acute coronary syndrome showed a significant increase in the concentration of IgG, CRP and fibrinogen. Analysis of the relationship between immunoglobulins and nutritional status markers showed that the IgG concentration correlated with the concentration of fibrinogen, but only in patients with myocardial infarction with persistent ST-segment elevation (p <0.01, r = 0.48). Another study published in 2014 by Song et al. (10) indicated the existence of a positive correlation between the serum IgM concentration and triacylglycerols (TG) (p = 0.0001 for trend), and a correlation with lowered HDL-C levels (p = 0.09 for trend) in men which was close to statistical significance. The authors also investigated the risk of metabolic syndrome according to IgM concentration. The odds of a ratio of metabolic syndrome between the fourth and the first quartile levels of immunoglobulin M was 1.19 for men (95% confidence interval, 1.002-1.41) and 1.39 for women (95% confidence interval, 1.07-1.80). In a study by Wilders-Truschnig et al. (11) evaluating the relationship between the concentration of IgG antibodies against food antigens and markers of inflammation in obese and normal-weight children it was shown that obese children have significantly higher levels of IgG (p <0.001), CRP (p <0.001) and the thickness of the intima media layer (Intima Media Thickness, IMT) (p <0.001) than normal weight children. Furthermore, IgG concentrations correlated positively with BMI (p = 0.002, r = 0.400), CRP (p = 0.001, r = 0.546), IMT (p <0.001, r = 0.513) and systolic blood pressure (p = 0.034, r = 0.569). However, there were no correlations between serum IgG and diastolic blood pressure, serum TG, total cholesterol (TC), LDL-C, HDL-C, fasting glucose and insulin.

Although there is evidence confirming the immune system's involvement in the development of inter alia cardiovascular diseases and metabolic syndrome, there are still insufficient data on the relationship between serum immunoglobulins and markers of nutritional status. The authors of this publication study the relationship between immunoglobulin concentration (G, M, A) and selected markers of nutritional status. The aim of the study was therefore to assess selected nutritional status markers (anthropometric parameters, lipid profile, fasting glucose) and to analyse the relationship between assessed indicators, inflammation marker - CRP and serum immunoglobulins G, A and M among adults.

Material and Methods

The study involved 57 women and 57 men with a mean age 58 ± 7 years for women and 57 ± 7 years for men. Inclusion criteria were: men or women aged ≥ 40 years. Exclusion criteria were long-term stay in hospital before the study, presence of genetic disease, type I diabetes, autoimmune disease, kidney disease, cancer. The protocol of the study was approved by the Research Ethics Committee of Poznan University of Medical Sciences and registered as no. 1016/13. Informed consents of patients were obtained.

Assessment of nutritional status was based on anthropometric measurements (weight, waist circumference, hip circumference) and calculated on the basis of their body mass index (BMI) and waist-to-hip ratio (WHR). Lipid profile indicators and fasting glucose were also evaluated. Furthermore, the concentration of immunoglobulins G, A, M, and C-reactive protein (CRP) was measured.

Total cholesterol (TC) was determined by the enzymatic colorimetric test, the concentrations of HDL cholesterol (HDL-C) by the accelerator selective detergent method and LDL cholesterol (LDL-C) using the calculation method (Friedewald formula) (12). For those patients whose serum triacylglycerols (TG) exceeded 300 mg / dl direct method was used. TG concentrations were determined by the enzymatic method. Fasting glucose was measured using hexokinase, the concentration of immunoglobulins by the immunothurbidimetric method and the concentration of C-reactive protein by the high sensitivity method (hsCRP).

Gender differences in nutritional status markers assessed by one way analysis of variance (ANOVA). The presence of the relationship between anthropometric parameters, lipid profile, fasting glucose, CRP and immunoglobulins G, A, M concentrations was evaluated by linear regression analysis. Statistical analysis was performed using Statistica 12 software produced by StatSoft.

Results

The mean values of anthropometric parameters of the subjects are presented in Table 1. It has been shown that men had a significantly higher BMI, waist circumference and WHR than females. Mean BMI in both groups was in the range considered as overweight (13). Classification of these men and women according to BMI showed that 42% of men and 37% of women were overweight and obesity was diagnosed in 30% of the men and 23% of the women. The rating of obesity type based on WHR (13) allowed abdominal obesity to be diagnosed in 68% of the women and 34% of the men. The mean values of waist circumference in both groups exceeded the boundry values. Individual analysis showed that 65% of the women and 65% of the men had an elevated waist circumference.

Table 2 contains the mean values of the lipid profile markers, fasting glucose, immunoglobulins G, A, M, and C-reactive protein. Significant differences between the selected markers in the women and men were observed only for HDL-C and IgA. The mean concentration of the TC and LDL-C fraction was elevated in both groups (14). Individual analysis showed that 72% of the women and 68% of the men had elevated levels of TC, 65% of the women and 67% of the men had elevated plasma LDL-C, and 25% of the women and 32% of the men had abnormal serum TG levels. An excessively low concentration of serum HDL-C was observed in 11% of the women and 12% of the men (14). Impaired fasting glucose concerned 32% of the women and 37% of the men (15).

Regression analysis between age, anthropometric parameters, lipid profile indicators, fasting glucose, CRP and serum immunoglobulin G, A and M in the study population showed a positive correlation between serum IgA and WHR ($p < 0.001$, $r = 0.30$) (Fig. 1) and between the same immunoglobulin and waist circumference ($p < 0.02$, $r = 0.28$) (Fig. 2). No statistically significant correlations between the remaining nutritional status markers, C-reactive protein and serum immunoglobuins were observed.

Table 1. Anthropometric parameters of the subjects.

Parameter	Study group	
	women	men
Body mass (kg)	68.5 ± 11,6[b]	84.9 ± 16.7[a]
BMI (kg/m^2)	27.1 ± 5.1	28.6 ± 9.1
Waist circumference (cm)	84.8 ± 10.9[b]	98.8 ± 12.62[a]
Hip circumference (cm)	102.8 ± 9.0	103.4 ± 7.0
WHR	0.8 ± 0.01[b]	1.0 ± 0.1[a]

[a, b] statistically significant difference between the men and the women in the study group at $p < 0.05$

Table 2. Lipid profile markers, fasting glucose, CRP, IgG, IgA, IgM of the patients.

Parameter	Study group	
	women	men
TC (mg/dL)	216.8 ± 52.0	214.1 ± 38.1
C-HDL (mg/dL)	62.12 ± 12.0[a]	54.3 ± 15.1[b]
C-LDL (mg/dL)	136.8 ± 37.0	131.8 ± 29.8
TG (mg/dL)	118.5 ± 50.9	149.5 ± 113.6
CRP (mg/L)	1.4 ± 1.0	1.5 ± 1.2
aqFasting glucose (g/dL)	96.6 ± 19.8	98.8 ± 17.5
IgG (g/L)	11.7 ± 2.6	11.7 ± 2.2
IgA (g/L)	2.1 ± 1.1[b]	2.9 ± 1.1[a]
IgM (g/L)	1.2 ± 0.8	1.4 ± 3.3

[a, b] statistically significant difference between the men and the women in the study group at $p < 0.05$

Discussion

Evaluation of nutritional status showed that the vast majority of the men and the women in the study

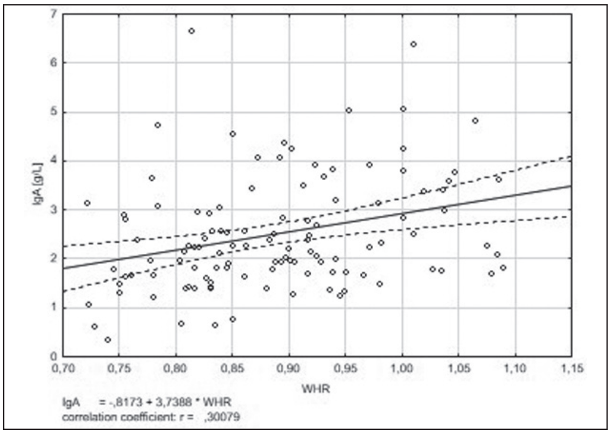

Figure 1. Correlation graph between IgA and WHR

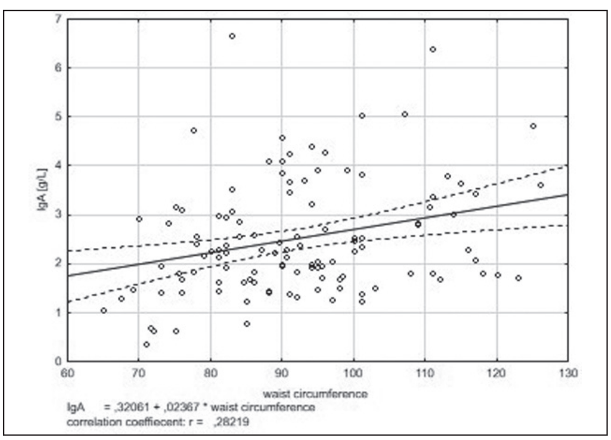

Figure 2. Correlation graph between IgA and waist circumference

population were overweight or obese. Based on the diagnostic criteria for WHR adopted by the World Health Organization (WHO), abdominal obesity was diagnosed in the majority of the women and a substantial proportion of the men. In terms of waist circumference, the vast majority of both the men and the women were characterized by abdominal obesity. A major problem in the study population were also lipid profile disorders and impaired fasting glucose. This is not surprising in the context of the long-known relationship between excess body weight and the increased incidence of lipid profile and carbohydrate metabolism disorders. Other researchers also point out that obesity and the resulting metabolic disorders occur in a significant percentage of the Polish population (16-18).

The analysis of the relationship between age and the nutritional status markers studied, inflammatory marker - CRP and serum immunoglobulin G, A and M for the entire study population showed a positive correlation between serum IgA and WHR and between IgA and waist circumference. It should be noted that the study focused on the relationship between nutritional status markers and the concentration of serum immunoglobulins are rare. One of the few studies by Gonzalez-Quintela (7) rated the existence of the relationship between the immunoglobulin G, A and M concentration, alcohol consumption, smoking and markers of metabolic disorders in 460 adults. The authors also investigated the concentration of IL-6 as a marker of inflammation. Researchers have shown that age correlated positively with IgG and IgA concentration (P for trend <0.001 in both cases). Metabolic disorders such as obesity, metabolic syndrome components. i.e. visceral obesity, hypertriglyceridemia, hyperglycemia and high blood pressure were positively correlated with IgA concentration. Moreover, particularly strong dependencies were related to abdominal obesity and hypertriglyceridemia ($p = 0.001$ and $p = 0.02$ respectively). Significantly higher levels of serum IgA were also demonstrated in patients with metabolic syndrome compared to healthy controls ($p <0.001$). The IL-6 concentration correlated positively with IgA and IgG immunoglobulins (P for trend = 0.01 and 0.03, respectively). In this study, however, there was no significant correlation between IgG and IgM, and metabolic disorder markers. In the study population no correlation was found between immunoglobulin G and M and nutritional status markers and the inflammatory marker CRP. The concentration of IgA correlated only with waist circumference and WHR, which may be due to the small sample size. Different results were obtained by Song et al. (10), who observed relationships between IgM concentration and lipid profile markers (TG, HDL-C) in men and with the occurrence of the metabolic syndrome in both women and men. In turn, Wilders-Truschnig et al. (11) found that the concentration of IgG was significantly higher in obese children.

Conclusions

In conclusion, despite the few studies, discrepancies in the results obtained by different authors and unknown mechanism driving the increase in IgA concentration in patients with abdominal obesity, it is not that surprising that IgA concentration was correlated with abdominal obesity (waist circumference, WHR) in the study population. The results obtained confirm the hypothesis that the immune system is involved in the pathogenesis of obesity, in particular abdominal type. It must be remembered that adipose tissue, especially that localized around the viscera is metabolically active and secretes a number of proinflammatory substances. More research is needed to explore mechanisms related to an increase in serum IgA among the obese. A limitation of this study is the small sample (114 people), therefore further research is required to confirm the relationships detected.

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